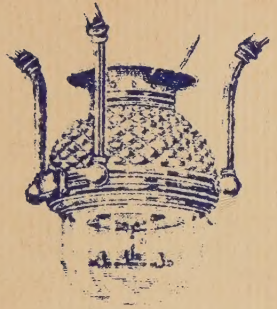

The Evolution of Artificial Light.

FOREWORD

This unusual booklet is perhaps the earliest treatise on artificial lighting published in the United States. It precedes Henry Chapman Mercer's "Light and Fire Making," published in 1898, by five years and is more a general history than is Mercer's.

It was published to promote travel on the Union Pacific Railroad which used a system of gas lighting in its coaches that was considered superior to kerosene and electricity. This reprint contains more than three-quarters of the original booklet, eliminating only the final portion that dealt with the railroad's routes to the Pacific Coast.

The proprietor of the copyright, E. L. Lomax, general passenger agent of the Union Pacific, is not known to be the author, but he did exhibit an interest in a variety of subjects, including an expedition in 1899 to what were called the Fossil Fields.

He did write "Union Station, Omaha" in 1890 and was the designer of the railroad's logo into which he worked in the old name of the road. The Overland Route, adding a touch of the past to the familiar red, white and blue shield. The reader will note the spelling of "Pittsburg" that was in use until the earlier years of this century.

Some unusual information on early times is provided in the booklet, none of which can be immediately substantiated. There also is a condemnation of an earlier society which must be considered solely the viewpoint of the author, whomever he may have been.

This reprint is offered to Club members as an interesting treatise on lighting "From a pine knot to the Pintsch Light." It was reprinted with the kind permission of the Union Pacific System.

THE PUBLICATIONS COMMITTEE,

Harry W. Rapp, Chairman, Charles F. McGurk, Mrs. Bette Rapp,
Mr. and Mrs. William R. Dixon, Mr. and Mrs. Raymond Schryver and Charles F. McGurk II.

THE EVOLUTION OF ARTIFICIAL LIGHT

FROM A PINE KNOT
TO THE PINTSCH LIGHT

COMPLIMENTS
PASSENGER DEPARTMENT
UNION PACIFIC SYSTEM
OMAHA, NEB.
1893

S. H. H. CLARK, President,
E. DICKINSON, General Mgr.,
E. L. LOMAX, General Passenger and Ticket Agt.,
OMAHA, - NEBRASKA.

Gift:
Rush Light Club
8-11-86

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General Passenger and Ticket Agent
Union Pacific System
Omaha, Neb.

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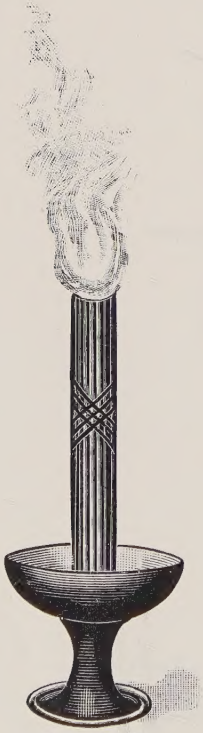
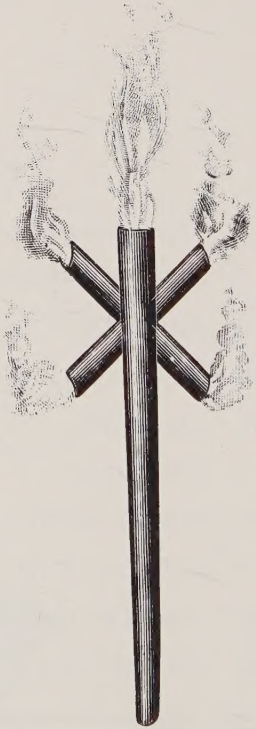
Persian Torch.



Pharos Torch.

Pine Torch.

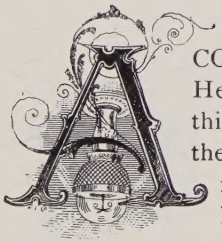


Greek Festival Torch.

Roman Lamp.

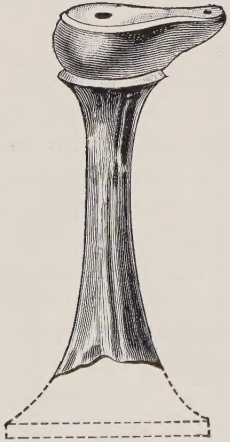
CHAPTER I.

"THE LIGHT OF OTHER DAYS."

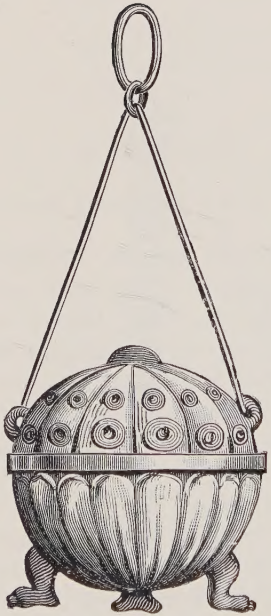


ACCORDING to the ancient legends, Prometheus was the first illuminator. He stole fire from the abode of the gods and brought it to earth, and, for this gift to man, was thrown out of heaven by the angered deities. So runs the fable—a theme for poet and painter for many thousand years. But, the matter-of-fact scientists tell us that primeval man went to bed at sunset; as he lived on herbs and fruits, a fire for cooking was unnecessary.

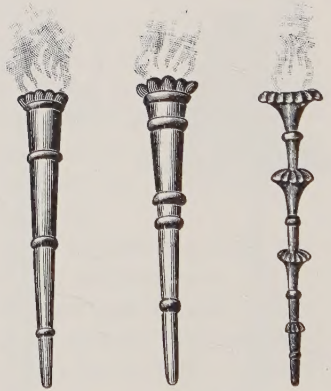
In tracing the evolution of artificial light, data bearing on the subject are obviously meagre regarding its inception. It is true we find in the prehistoric homes of the cave-dwellers and other races, whose origin is lost in an impressive past, utensils which indicate they were used in the rude cooking of the period. But, if the primeval man used fire and cooked his food, did he light his cave or tent of skins or his first wretched thatch? Did he eat and sleep even as the wild beasts by which he was surrounded? Have we any evidences of an attempt on his part, however clumsy and crude, to illuminate his primitive house, such as it was?



A GREEK LAMP.
Fifth Century, B. C.



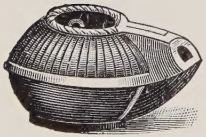
HANGING LAMP OF THE NINTH CENTURY.
From a Miniature in the Bible of Charles the Bald.



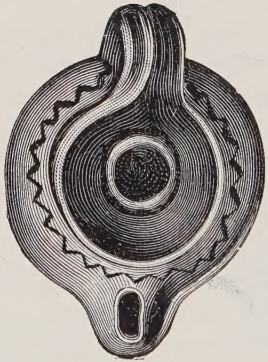
Roman Flambeaux.

We are told that among the early types of the human race it was the custom to rub briskly together two pieces of wood until the rapid friction produced sufficient heat for ignition. The striking together of two pieces of flint also produced a tiny spark of fire, which would ignite dry leaves or moss. Pine knots, sticks smeared with the resinous gum of trees, were probably used as house lights, if indeed any such light was customary; or it may be that there was a huge fire of wood built outside of the dwelling, supplying at once light, warmth, and protection from the savage beasts. For, search as we may, there is but little of any evidence bearing on this point. One object only comes always and ever into prominence. In the mute and swallow-like homes of the cliff-dweller; in the oldest of Egyptian tombs; among the most ancient remains of early Greece and Rome; embalmed in the legends and history alike of the Hindoo and Chinese; and even in the Book of Books itself, we are constantly confronted with—A Lamp. So faulty and vague are our evidences that it is well nigh impossible to note the line of departure—that point where man ceased to use a pine torch, or whatever barbarous contrivance he may have invented—and evolved the lamp. But of this we may be sure; it is one of the most ancient methods of artificial light for house use known to man.

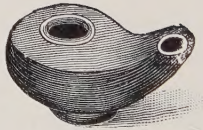
If, on the one hand, we find in the old heroic times of Britain, that pine torches sufficed for light, and that the smoke from the fire in the great hall had no vent, that the houses had no windows of glass; on the other hand, we know that the Greeks and Romans centuries before had an infinite variety of lamps, that they used papyrus, horn, and a transparent thin



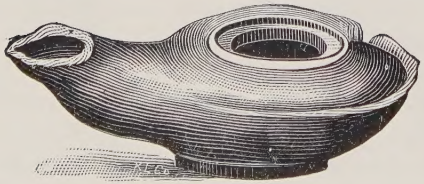
EGYPTIAN LAMP.



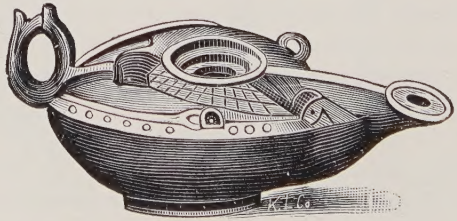
EARLY CHRISTIAN ERA LAMPS.



EGYPTIAN LAMP.



EGYPTIAN LAMP.



EGYPTIAN LAMP.

stone in place of window glass, and that the residence of many a Roman patrician was heated by a furnace, on much the same principle as we employ to-day. So the lamp, in some form or other, continually appears, is lost for a time, and reappears again in all the countless changes of history through many slow, revolving centuries.

EGYPTIAN LANTERN.

CHAPTER II.

HOUSE LIGHT, TORCHES AND LAMPS.

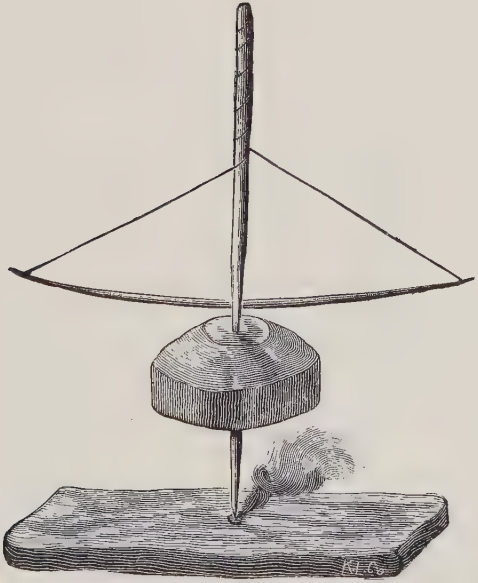
IN reviewing the history of artificial light one naturally questions what manner of houses were inhabited by the ancients and the men of more proximate time. As this is germane to the subject in hand a brief account of the home dwelling at different periods may prove interesting. It is probable that the earliest dwellings of man were natural caves. The cave-man lived in the rocky clefts along the Red Sea, on the Danube, and along the shores of the Mediterranean. Modern researches show that the first inhabitants of France and England found shelter in deep caves, hiding from the savage beasts, and defending themselves with bows or spears. Others of the race, apparently more intelligent, built platforms on piles in the Swiss Lakes, raised their huts in the midst of the waters, and thus escaped the fury of the mammoths and elephants which roamed through the forests of Europe. The Esquimaux finds happiness in a house of snow or in rude piles of stone stuffed with moss. Some South American Indians build with the birds in the branches of the trees. Among the Romans the earliest houses seem to have been a single apartment, built perhaps of clay, with an opening in the wattled roof to admit

ROMAN LAMP.

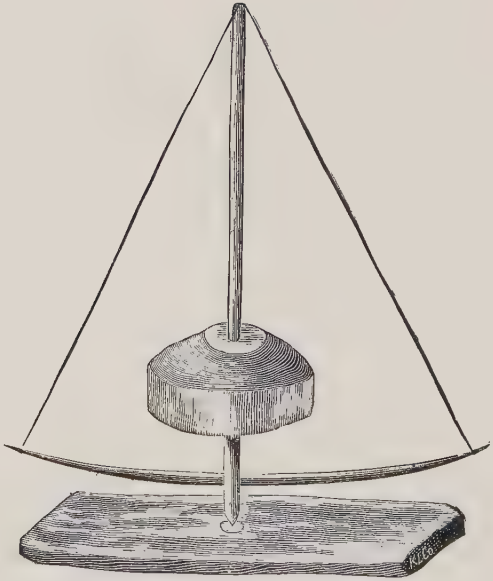
ROMAN LAMP.

the passage of smoke. When the nation advanced in knowledge this atrium, or open hall, was always preserved; it was the usual place of meeting for the family. The impluvium—a basin to receive the water which fell through the roof—became a necessary part of every dwelling, and was often adorned, in the later ages, with wasteful extravagance. From their simple huts of clay the Romans came at length to build the most magnificent of human dwellings. Their costly marbles and delicate paintings, their immense halls and lofty palaces, their luxurious manners and moral decay, are contrasted by the satirists with the rigid virtue which prevailed in the thatched dwellings of their ancestors. Roman artisans, in the republican period, were accustomed to build tall houses on the principle of coöperation, each family owning a series of apartments; in the imperial times, the industrious where plundered and their homes leveled, that a Nero or a Claudius might occupy a palace as large as a city.

The least convenient residences seem to have been the castles of the Middle Ages. Seated upon some rock or frowning cliff, secure, at least, from the general anarchy that reigned below, the huge interior tower was surrounded by massive walls provided with narrow loop-holes for windows, was entered by a low doorway, and gave but little satisfaction to any of its inmates, except the savage baron and his band of robbers. The fair dames of chivalry must have languished in their prison-like homes. The small window-like apartments seethed with the heat of summer or invited the fierce blasts of winter. The battlements offered the only safe place of exercise. The great hall, strewn with rushes and defiled with accumulated filth, was the scene of brutal revelry and murderous quarrels; neatness,



IROQUOIS FIRE-DRILL.—Two-thirds wound up.



IROQUOIS FIRE-DRILL.—Unwound.

decency, and good order were unknown in the abodes of chivalry; nor is it wonderful that in such homes men degenerated into unscrupulous robbers, that the women were so often vile, that children were trained in ignorance and vice, and that the corrupt nobility became the terror and scourge of mankind.

The palace succeeded the castle, but with little advance in the morals or even the comforts of its inmates. The stately homes of Genoa or Venice were grand and cheerless; the chief palace of France and of Europe was unhealthy, damp, repulsive even to its builder. St. Simon tells us that Versailles, built from the plunder of a starving nation, was wholly unfit to live in. Louis XIV fled from his magnificent folly in disgust.

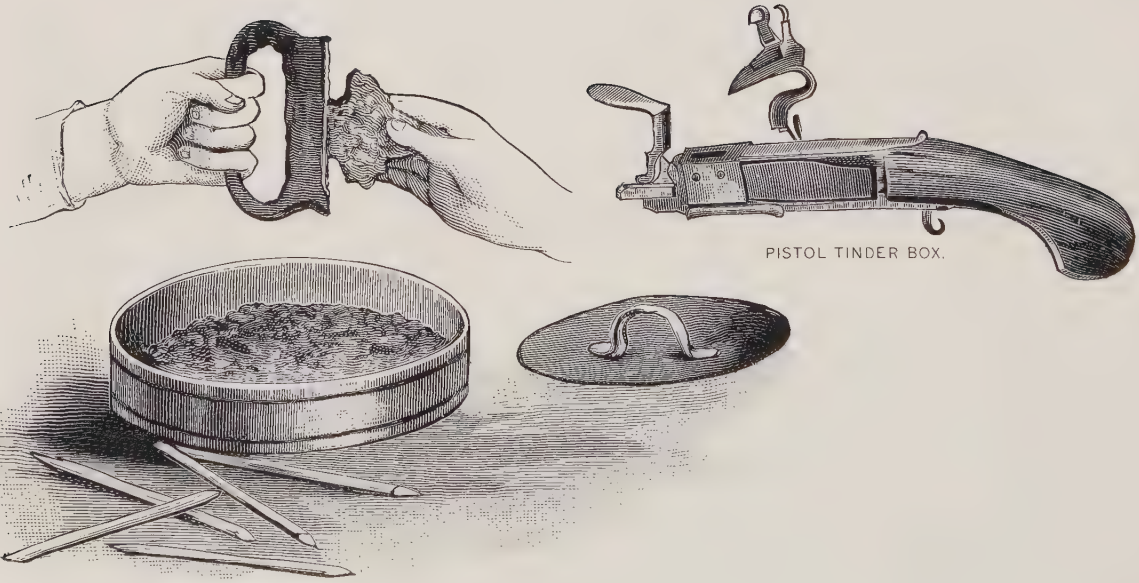
Happily, the art of house-building has advanced with the course of invention. The modern artisan and merchant may live surrounded by comforts that Nero or Caligula could not purchase. In the fresh, bright climate of America the modest home of the industrious is supplied with warmth, light, abundant water, cleanliness, and security; his rooms are more cheerful than the chambers of Versailles, his windows larger than those of the palace of the Cæsars.

Where positive and accurate information is lacking in matters historical we usually find a primitive custom surviving amongst the lesser civilized peoples, which naturally indicates great antiquity. The production of fire by wood friction is, as already stated, very ancient; the custom is preserved to-day in many parts of Australia and is still practiced in Kaffirland. The Esquimaux uses a bow-drill even now. The wood of the chestnut tree was commonly used by the ancients in producing fire by friction.

The ancient Romans used to call the wick of the lamp, a "match." The Greek word for match means the nozle of the lamp, "a nostril," and the modern French word means "the wick of the candle." The ancient Romans were well acquainted with the use of the flint and steel. Steel appears to have been used as early as the time of Homer. The Chalybes, a people on the southern shore of the Euxine Sea, were celebrated makers of this metal. Isaiah mentions the "hammering of iron," and Jeremiah speaks of "iron from the north" as the hardest known. This was the country of the Chalybes. All of the ancient Greek and Roman poetry and history is full of allusions to this metal. In the more recent times, when tinder was in general use instead of matches, it consisted commonly of charred linen, which was ignited by the flint and steel in a metallic box. Formerly hemp, flax, cotton or tow, dipped in sulphur, coarse paper saturated with nitre, a species of dry wood called touchwood, were in common use as matches.

Readers of "David Copperfield" will remember that after he had run away from blacking bottles and found a refuge with his aunt, he perceived a strong smell as of something burning, and, on asking its cause, was told that the cook was making tinder out of his shirt. As long as the fabric of linen rag would hold together it was utilized for other purposes, and not until it was utterly past all use was it consigned to the tinder box. The matches of the period were thin, flat strips, pointed at each end, and with the tips dipped in melted sulphur. A recent author gives a graphic description of "striking a light when he was a boy:"

"When you wanted to light a candle at night, you had first to find the tinder box in the

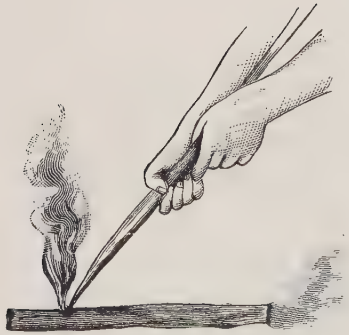


PISTOL TINDER BOX.

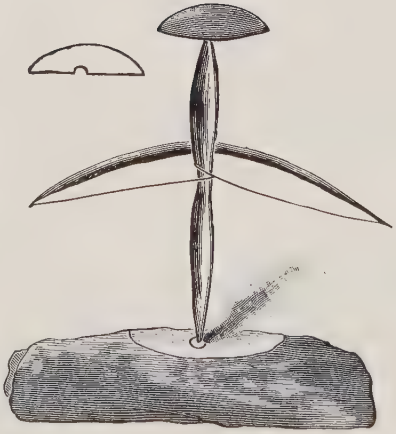
FLINT AND STEEL, TINDER BOX AND MATCHES.

dark. Then you had to secure the steel in one hand and a flint in the other, and then to remove the cover and lay the matches on the table. You had to be careful that there was no draught, as the least wind would blow the tinder out of the box. Then holding your hands over the box, you had to go on chip, chipping at the steel in the dark, holding the flint crosswise and not edgewise. Sometimes you hit the steel, sometimes you hit your knuckles, and sometimes you hit nothing, especially on a cold winter's night, when your fingers were so frozen that you hardly knew whether or not anything was between them. At last a spark would fall into the tinder and then you had to blow it until there was a patch of tinder alight about as large as a six-pence. Then the end of the match was applied to the tinder and well blown, while its suffocating fumes half choked you and filled the room with the vapor. When the little blue flame was at last evoked, the match had to be sheltered from all draughts, until the wood at last burst into flame and allowed the candle to be lighted. People with very luxurious habits provided themselves with a pistol tinder-box. It consists of a pistol stock without the barrel. The hammer is of course fitted with the flint, the instrument having been made at least fifty years before the invention of the percussion cap. Instead of the shallow pan, which held the priming powder, there is a square receptacle for tinder, and along the side of the stock there is an oblong chamber, closing with a spring, for the reception of the little matches which were made expressly for the purpose."

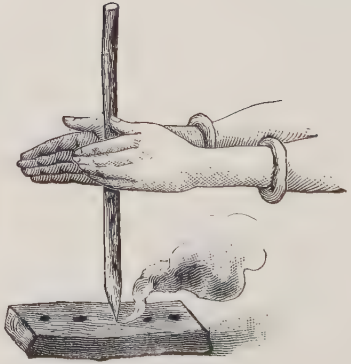
Early in the nineteenth century an improvement was introduced in the form of a thin slip of wood tipped with sulphur and other combustible matter, which ignited when brought



MAKING FIRE BY RUBBING WOOD.



DACOTAH FIRE DRILL.



FIRE-DRILL.

into contact with phosphorus contained in a box or vial. All other domestic devices of the kind, however, were superseded by the friction match, which was introduced about 1830. The invention of the Lucifer match has been accredited to Godfrey Hanckurtz, of Vienna, in 1680, but the statement lacks authority. The Locofoco matches of 1834 are by many still remembered. The word "locomotive" was just then becoming familiar, and was supposed by the inventor of the wood locofoco to mean "self-moving," whence "locofoco" was intended to mean "self-lighting."

It is the opinion of many distinguished scholars that torches were the only illuminants used by the Greeks and the Romans prior to the fifth century B. C. They are mentioned by Homer as being represented on the shield of Achilles. Torch races were also a feature of certain Greek religious festivals. Resinous wood was used or wood saturated with oil. The torches when used in the houses were constructed similarly to those used at the present time in the Greek church, being simply bowls or fire basins. Among the ancients these bowls were made of terra cotta or copper, and were placed on pedestals in which wood mixed with resinous matter was burned. In the Egyptian hieroglyphics, in the remains of Assyrian sculpture, and among Asiastic races, the torch is represented. The torch is still used for a light by the poorer classes in Mexico.

"Lamps," says Dr. Schlieman, "appear to have been totally unknown in Greece and Asia Minor before the sixth century B. C." But they claim greater antiquity among the older empires, far beyond recorded history. No article of ancient manufacture is more common. They are found in every variety of form and size, in clay and metal, of the

cheapest as well as of the most costly description. The external form of the lamp was more of a study to the ancients than its usefulness as a light-giver. They gave to it the most graceful outlines, ornamenting it with grotesque figures and fanciful designs which were often of great beauty. Some of the bronze lamps taken from Pompeii are marvels of exquisite workmanship. In the house these lamps were suspended from the ceiling, or from the hands of ornamental figures of boys or men, or they were placed on stands. But, beautiful as they were, the light they gave must have been weak and unsteady ; the wick was merely a few twisted threads drawn through a hole in the upper surface of the oil vessel ; there was no glass to steady the light and prevent it varying with every breeze. The simple form of this lamp, adopted as far back as ancient Hebrew times, has continued in use to the present day. Among the Canadian French may still be seen the same low oval metal vessel which was used by the ancient Orientals and Europeans, furnished with a handle at one end and a beak at the other, through a hole on the upper surface of which projects the wick from the reservoir of oil or grease below. Some are made to be carried in the hand and placed on tables, and others are suspended by chains in the middle of the room.

The invention of lamps is ascribed to the Egyptians. Their use was known in the days of Moses and Job. The application of lamps passed from Egypt into Greece where they were consecrated to Minerva, the goddess of learning, as indicative of the scholar's nocturnal study. From Greece the use of lamps passed to Rome. Among the Egyptians, Hebrews, Greeks, and Romans oil lamps were generally used, and they vied with each other in the con-

struction of the instruments. Some of the specimens which have been preserved to the present time display much taste and elegance of design. The interiors of all of them, however, are rough and meagre.

The most primitive lamps were probably the skulls of animals, in which fat was burned, and certain sea shells formed admirable lamps for those to whom they were attainable. To this day may be seen occasionally suspended in the cottages of Zetland shells of the "roaring buckie," which is perhaps the most ancient lamp in existence.

Among the northern nations of antiquity lamps were in use, but the climate necessitated a different kind of vessel. The limpid oils of the present day were unknown to our Celtic and Saxon forefathers, besides the cold winters would have solidified them, and they would not have been drawn up by the wick if arranged as in the old Roman and Greek lamps. The solid fat of various animals was their chief illuminating material, except on the sea coast, where seal and whale oil occasionally helped them.

It would appear that the ancients at first constructed their lamps of baked earth; but subsequently of various materials, bronze especially. There are a few lamps of iron extant, but they are rare, either because that metal was little used for the purpose or on account of its rapid decomposition in the ground. There are four specimens in the Museum of Portici, and one specimen of a glass lamp, which is entirely solid and in one piece. A golden lamp in the temple of Minerva is mentioned by Pausanias, and St. Augustine speaks of lamps of silver. There was a strong belief amongst ancient writers that perpetual lamps existed. Instances have been cited by various authors where lamps were found burning in ancient sep-

ulchers, which were extinguished as soon as the air was admitted. In the pontificate of Paul III. one of these lamps was found in the tomb of Tullia (Cicero's daughter), which had been shut up for 1550 years. At the dissolution of the monasteries a lamp was found which is said to have been burning 1200 years. Two have been preserved in the Leyden Museum The lamps or candles used by the Jews in their own houses were put into a high stand raised from the ground. The lamps used by the wise and foolish virgins, mentioned in the New Testament, were of a different kind. Critics and antiquaries seem to agree that they were a kind of torch made of iron or potter's earth, wrapped about with linen and moistened from time to time with oil. It has previously been noted that it was customary among the Romans to have a lamp either hanging from the ceiling or placed on a stand in the room. These stands were often richly ornamented. It was also the Roman custom on occasions of national rejoicing to have public illuminations, on which occasion lamps were suspended from the windows. The practice of placing lamps in the sepulchres of the dead was probably meant to be allegorical of the cessation of earthly existence. Some of the sepulchral lamps are sculptured with the figure of a butterfly in reference to the escape of the soul. The early Christians adopted this usage in their monuments, and lamps have been found in the tombs of many saints and martyrs.

There is one mention of an attempt at improvement. Hero of Alexandria (B. C. 221), in his treatise on Pneumatics, details four inventions, by one of which he says, "Oil can be raised by water within its stand," and by another, "raised by means of air." All of these old-time lamps formed a crust on the wick, which was removed by a needle or pick; but

none of them gave a good light, and we can have no conception of the wretched, limited, artificial light used even by the wealthiest class before the era of lard oil, camphene, gas and hydro-carbons.

Until 1782 all lamps were dim, smoky, ill-made articles, soiling everything they came near, and filling the air with anything but an agreeable odor. The invention and introduction of the Argand lamp at that time, by Amiè Argand, made a revolution in illumination.

In closing this section, regarding the antiquity of lamps, attention is called to a very curious historical fact, namely : that there was no change whatever in the evolution of the lamp from the most ancient times until a period as recent as a century ago. Artistic taste had been shown in design, but all improvement stopped short at decoration.

In 1782 or 1784—the authorities differ on the date—Amiè Argand, according to others, M. Quinquet, invented a burner with a circular wick, the flame being thus supplied with an outer and inner current of air, the effect of which was increased by means of a glass chimney. Argand was also the inventor of the chimney itself as applied to other lamps. Soon after Argand, Peter Keir, in 1787, made the great invention which was only fully developed of late by Aronson, by raising the supply of oil by means of another fluid whose specific gravity is greater than that of oil, this being generally salt in water. The principal inventions since his are as follows :

John Miles, in 1787, invented a portable carriage lamp, also one with a reservoir, on the same principle as a bird cage water fountain and a burner of twisted wire. Thomas H. Stokes, in 1787, patented a new and peculiar method of raising oil in lamps to supply wicks,

and J. Smithurst (1791) and J. Lucas, with W. Baylis (1793), made ingenious application of lenses to light. Eckhardt and Morton, 1797, set forth a method of making lamps and candlesticks by means of sliding pillars, so that they may be raised or contracted. M. Carcel, in 1798, invented a lamp in which the oil was raised by clock work. This, and Stokes' lamp, are the parents of the moderator lamp. About seventy varieties of this, or the pressure lamp, have been patented in England. A modification of the Carcel lamp, known as the Diacon, was long popular in America. In 1849, an American, named Wood, wrote a singular novel, consisting of the adventures of a lady in search of a really good lamp, in which the successful end was the attainment of the Diacon. James Smithurst and Michael Paul, 1802, patented the register air tube and a really movable burner with reflectors. Porter's "Automaton," 1804, was very ingenious, the lamp being suspended on an axis, counterbalanced by a weight, so as to make it hang level when full, at an angle of forty-five degrees; when empty so as to feed itself evenly by the gradual ascent of the burners. G. B. Alcott, 1806, supplied oil by means of a piston and tube; also with a tube and syringe which forced the oil up with compressed air, or any other heavier fluid than oil. Elizabeth Perryman, 1809, invented an improved street and hall lamp. J. Smithurst, 1811, offered several improvements, one of a spiral burner with a screw valve; also the double cone globe. Peter Durand, 1811, attempted to render illumination more soft and agreeable to the eye. Lord Cochrane, 1818, invented the lamp for burning the spirit oil, or oil of tar, and made an arrangement for allowing the direct rays of light to fall perpendicularly to the ground beneath the flame. Samuel Parker, Jr., 1822, made the important advancement of fixing French

chimneys upon burners by means of metal supports affixed to the burner adjuster of the lamp wick. J. C. Hadden and J. Johnson, 1838, invented an ingenious candle lamp with a spring, the candle being without a wick, the wick being a short tube above, up to which the candle rose as it melted. Robert Rettie entered, in 1845, an improved method of signaling on sea or land, with colored glass lamp shades or reflectors ; also an excellent arrangement for reflectors in lighthouses. W. C. Wilkinson, 1846, devised a number of inventions connected with raising oil by atmospheric pressure with gas burners and heating gas. Robert Hesketh, 1852, claimed the invention of the combination reflector; also that of glass in corrugated sections, every alternate face being silvered. Edwin Whale, 1852, invented candle lamps which did not require snuffing, and candle clocks. Abel Easton, 1853, patented a self-generating gas lamp, the gas being made from spirits of wine. Edward Maneire, 1854, patented lamps in which the oil reservoir was raised above the surface of the burner, and so placed that its minor surface acted as a reflector. E. Simons, 1855, invented an apparatus for condensing and absorbing the smoke arising from gas and other flames, and increasing the light. Theodule Cave, 1856, invented a continual lamp to burn twenty-four hours without requiring attention, by means of plunger and elastic rubber tube. John McDonald, 1856, presented the improvement of regulating oil for lamps. Charles E. Hanks, 1856, contrived an improved apparatus for illuminating objects beneath the water, or lighting mines where explosive gases exist. This was another form of safety lamp, originally invented by Dr. Clanny, of Sutherland, in 1813, and perfected by Humphrey Davy and George Stevenson, in 1815. Concerning later improvements and inventions the list is too long to be reproduced here.

CHAPTER III.

CANDLES, LANTERNS AND LINKS.

HEN we read of the golden candlesticks which were used by the wandering Israelites in their first Desert Tabernacle, the impression conveyed to us is that of an article familiar in our own times. "Candelabra," however, does not mean a word with which we can associate our modern "candle." It is quite certain that the Latin word "candela" meant nothing more nor less than a lamp, and the candelabrum was the support upon which the lamp was placed. In the tabernacle of the temple at Jerusalem, the golden candlestick, or more properly, candelabrum, stood on the left hand of one entering the holy place, opposite the the table of show bread. This candlestick had six arms, and there were seven lamps surmounting the shaft and the arms. These lamps were supplied with pure olive oil and lighted every evening. In the first temple there were ten candelabra; in the second temple there was but one, resembling that of the tabernacle. This was carried to Rome on the destruction of Jerusalem; it was lodged in Vespasian's temple to Peace, and copied on the triumphal arch of Titus, where its mutilated image is yet to be seen.

The forms of lamps so far noticed were not adapted for being carried about in the hand; indeed, it may be said that very slow progress was made in the production of economical, safe, and convenient small lamps. The vapor lamps, which burnt the vapors arising from a mixture of oil of turpentine and alcohol, promised to meet this want, but they were both expensive and dangerous. To these succeeded a variety of lamps for the burning of camphene and alcohol. These have passed out of use as being unsafe. Coal oil and petroleum have introduced the kerosene lamp—beyond all question the lamp of the period, possessing, as it does, all the advantages of cheapness, portability, brilliancy of light, and entire safety. A multitude of burners have been contrived for this lamp—all made with reference to effecting the most thorough combustion of the oil.

Our modern word "chandelier" originally signified "a candlestick," then "a cluster of candlesticks;" finally the distinction became established between a candelabrum, which is a standard, and a chandelier, which is a pendant. The word luster has also been used to designate a branched candelabrum or chandelier ornamented with prisms or pendants of glass.

The time at which candles were first used has not been ascertained. They are mentioned in the Old and New Testaments, but the context proves in every case that the Hebrew word should be translated "lamp" and not "candle." Pliny describes a candle made of brittle rushes, which very clearly corresponds to our more modern rush-lights. In the later days of the Romans, wax candles were much used, but only by the upper classes, as they were very expensive. These so-called wax candles, as we have previously noted, were made by

dipping rushes into pitch and coating them with wax. In the middle ages candles of the same material were made, weighing as much as fifty pounds. The candle clock of Alfred the Great, and its conversion into a lantern, by means of a translucent horn cover, by which he divided the day into three equal portions, is familiar to most readers. In ancient times, in England, sales "by the candle," or "by the inch of candle," which are still occasionally advertised, derive their name from an ancient practice of measuring the time within which the biddings must be completed by a candle, the highest bidder at the moment the inch burns out becoming the purchaser. It was not until the fourteenth century that candles, bearing any resemblance to those now in use, were manufactured. Previous to that time our English ancestors soaked splints of wood in fat oil to obtain light. A dipped candle made from tallow was introduced into England in the fourteenth century, and wax candles were also made at the same time. These last were very costly and were considered great luxuries. In 1484 a company for the manufacture of wax candles was incorporated in London. Mold candles are said to be the invention of Sieur Le Brez, of Paris.

A host of traditions cluster around the candle, and it has been associated with innumerable legends, religious ceremonies, and omens for good or evil. An old custom was to sing the "candle hymn," a song sung at the lighting of the candle at sunset. "To hold a candle to the devil"—to aid that which is wrong. The use of candles at funerals is a relic of Roman custom. Candlemas Day; this is the 2d of February, when, in the Catholic church, there is a candle procession to consecrate all the candles which will be needed in the church during the year. Candle power: the standard usually employed for this purpose is a sperma-

cetti candle, burning at the rate of one hundred and twenty grains of sperm per hour. Bell, book and candle: used in exorcism and excommunication. There is a mineral candle made from a semi-fluid, naphtha, obtained from wells in Burmah. Then we have the candle berry tree, candle fir, a candle fish, a candle fly, a candle nut, and candle wood.

The rush-light or rush-candle, which has been the "poor man's light" for many centuries, was prepared by stripping a dried rush of all its bark except one small strip, which held the pith together, and dipping it repeatedly in the tallow. The Chinese put rushes to the same use, while the Japanese use the common rush for making mats, which serve for carpets and beds; light mats of the same material and covered with transparent paper are used as window curtains. There are about fifty species of this plant in all North America.

According to the habits of good society which prevailed in the reign of James I and Charles I, courtiers, proceeding home after dark, were conducted with torches, merchants with links, and mechanics with lanterns. This would seem to indicate the kind of lights used by the different classes of society at that time. Lanterns are spoken of by the Greek comic poets. These articles were also known to the Egyptians.

It is remarkable that the only trace of a lantern which the Egyptians offer is that contained in the accompanying illustration. The celebrated Feast of Lanterns is held in China on the fifteenth day of the first month of the year. It derives its name from the vast number of lanterns which are hung out of the houses and in the streets, the number of which has been stated to exceed two hundred millions. The lanterns used are often of great value, some being estimated at two thousand crowns. They are richly ornamented with gilding,

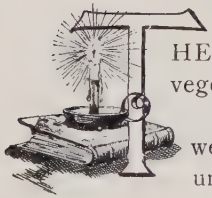
painting, japanning, sculpture, etc. Some of them are of great size, reaching nearly thirty feet in diameter, and are so constructed to represent halls or chambers; hence two or three together would make an elegant house. In this way the Chinese may be said to live, to receive visits, dance and act plays in a lantern. When lighted up with torches, these lanterns have a beautiful effect at a distance. Besides the large lanterns there are a vast number of smaller ones, which usually consist of six faces or lights, each about four feet high and one and one-half broad, framed in wood, finely gilded and adorned. Over these they stretch a fine transparent silk, painted with flowers, trees, and other objects ; the colors are very vivid, and, when the lanterns are lighted up, the effect is lively and picturesque.

The old spelling of lantern was lanthorn, in supposed allusion to the transparent plates of horn which often formed the sides of lanterns. The earliest form appears to have been a collapsing corrugated tube of some semi-transparent fabric, inclosing a lamp or candle. This form survives in the Chinese paper lanterns. Lanterns have been made of horn, talc, mica, perforated metals, oiled fabrics, paper and glass.

A link was simply a torch made of tow, tallow and pitch, formerly very common in England, and of great antiquity in that country. Improved street lighting has made the employment of link boys generally unnecessary; but they are still required in London, during the dense fogs frequently occuring there. "Not fit to hold a candle to :" this old English expression signifies a very inferior person. The allusion is to link-boys who held torches or links to light pedestrians.

CHAPTER IV.

OIL LIGHT.



THE oil used by the Egyptians, Hebrews and Greeks in their lamps was generally vegetable, but, according to Pliny, sometimes of liquid bitumen.

Coming to modern times it may be remarked that animal fats and fish oils were the principal substances used in all parts of the world for burning in lamps until the introduction of mineral and vegetable oils. Previous to the introduction of these oils camphene was largely used. This is a volatile hydro-carbon spirit distilled from turpentine, and was burned in Young's "Vesta" lamp in 1834.

The kinds of oils for burning in lamps varies in different parts of the world with sources of supply. Whale oil is used in Great Britain, but seal oil, fish oil and oils obtained from seeds by pressure are also largely consumed. In Paris the oils of rape seed and of poppy seed are used, and in the south of France and in Italy an inferior kind of olive oil and also the oil of the earth-nut are employed. In the latter country a lamp oil is expressed from grape stones. In Piedmont walnut oil is common; oil of sesamum seed is burnt on the eastern and southern coasts of the Mediterranean, while in tropical countries cocoanut

oil—which is solid in the climate of Great Britain—is generally used. In China the Camellia oleifera is cultivated for the sake of the oil. The export of oils from the East Indies, especially gingelly, has greatly increased. Pistachio nut oil is becoming common, as is also groundnut oil from Africa. All these oils are used for burning in lamps.

The word petroleum is derived from two Latin words: "petra," a rock, and "oleum," oil, whence its name, "rock oil." It was known to the ancient Greeks and Romans, and by Pliny, Tacitus, Vitruvius and other Roman writers was designated bitumen, a word derived from the Greek, "pitch," and probably first written pitumen. Among the localities cited in which the liquid bitumen was found is Zacynthus, now Zantel, one of the Ionian Islands. As it is referred to by Herodotus, this spring must have been flowing for more than 2,000 years. At Agrigentum, in Sicily, the petroleum was collected and burned in lamps. It was but little noticed during the middle ages, excepting in certain localities where it occurred in large quantities; but in modern times it has become one of the most important of natural productions. It occurs in rocks or deposits of nearly all geological ages, from the lower silurian to the tertiary epoch.

Petroleum is very widely distributed, yet there are a few localities especially noted for its occurrence, among which are the following: Amiano, and other places in the north of Italy, which have furnished the supplies for lighting the cities of Parma and Genoa; Baku on the borders of the Caspian; the slopes of the Caucasus; Rangoon in Burmah; the island of Trinidad, and portions of the province of Ontario; Pennsylvania, Ohio, New York, West Virginia, California and Wyoming. In northern Italy, in the former duchies of Parma and

Modena, petroleum has been extracted from the earth since its first discovery in 1640, the method pursued being merely to sink pits, and collect the fluid that exudes from the soil in little basins or reservoirs at the bottom. Various sorts were gathered from different localities, and their peculiar properties appear to have been correctly observed, but no method of purifying them was employed; on the contrary, the lighter and better oils were made the medium of utilizing the poorer sorts by mixture. The west shore of the Caspian has been celebrated from remote periods for the extraordinary quantities of inflammable gases and liquids that rise from the surface of the ground. The Rangoon district on the Irrawaddy is quite as wonderful for its immense production of rock oil as Baku. For an unknown period the whole Burman empire and a considerable portion of India have been supplied with oil from this source. The trade is carried on by means of large boats that come up the Irrawaddy to the town of Ramanghoung, a place inhabited by potters, who are constantly making the earthern jars in which the oil is kept. They are piled up in great pyramids about the town, ready for use.

The occurrence of petroleum about the headwaters of the Allegheny river, in New York and Pennsylvania, was known to the early settlers. The Indians collected it on the shores of Seneca Lake, and it was sold as a medicine by the name of "Seneca" or "Genesee oil." A stream in Allegheny Co., New York, was named Oil Creek, in consequence of the appearance of oil on its banks, and the same name was given to a creek in Venango Co., Pa. At points along the latter, springs issued from the banks of the stream, bringing up oil, which collected on the surface of the water as it stood in pools below the springs. The inhabi-

tants were accustomed to collect the oil by spreading woolen cloths upon the water and wringing them when saturated. Down the valley of this creek are numerous ancient pits, which appear to have been excavated for collecting oil, but by whom no one can now tell. From the fact that logs have been found in them notched as if with an axe, some have supposed that the work was done by the French, who occupied this region in the early part of the last century ; others believe that the Indians, who are known to have valued the oil, dug the pits. Petroleum acquired a reputation as a medicine before it was used for other purposes, and there is no doubt it possesses some virtues, especially as an outward application in diseases of the skin, chillblains, rheumatism, etc. Taken internally, in doses of thirty to sixty drops, it acts as a sudorific and stimulating anti-spasmodic. It has been recommended for disorders of the chest, and in Germany as a remedy for tapeworm. Its use for illuminating purposes has become of vast importance, and it is becoming each year of more extended application in technology, the waste products of its manufacture yielding a great variety of useful products.

First in importance among the products of petroleum is illuminating oil or kerosene, both in respect to the vast bulk of the commodity, and also the large proportion of the human race dependent on it for artificial light. When compared with the methods in use half a century ago, illumination by means of this material has prolonged human life over half the habitable globe, and it is the cheapest and most perfect illuminating agent yet discovered.

The word kerosene is derived from the Greek, and means "wax." It has been prepared

from bituminous coal, bituminous shales, asphaltums, malthas, wood, resin, fish oil, and candle tar ; but it is now almost exclusively obtained from petroleum. It is produced in greater or less quantity during the destructive distillation at moderate temperatures of nearly all organic and mineral substances containing carbon and hydrogen. It has been obtained for commercial purposes in enormous quantities from the petroleum of Pennsylvania, Ohio, West Virginia, Wyoming, Rangoon in India, the Caucasus, and other localities, and in less quantities from the cannel coals of England and the United States, the boghead shale of Scotland, the albertite of New Brunswick, the asphaltum of Trinidad, and common resin. It has been prepared in small quantities from the malthas of Southern California and from menhaden oil.

The manufacture of this product as an article of commerce has developed into enormous proportions. Its unsurpassed qualities as an illuminating agent, together with its cheapness, when compared with other substances used for that purpose, has caused it to penetrate to every region whither its transportation is possible. Like many other of the great industries of the world, it has arisen from repeated and very small beginnings. The extraction of oil from bituminous substances, as shales, coals, asphaltum, etc., is no new discovery. The first announcement that oil might be thus procured, is contained in the specifications of a patent granted in England, in 1694 to Martin Eele, Thos. Hascock and William Parttock, for "a way to extract and make great quantities of pitch, tar and oyle out of a sort of stone of which there is sufficient found within our dominion of England and Wales." The stone proved to be a bituminous shale ; but no practical results appear to have followed the discovery and the

patent. In 1716 the Messrs. Betton, of Shrewsbury, patented a process for extracting oil from the black, pitchy, flinty rock commonly found overlying the coal beds. This must have been the bituminous shales; and their method was to grind them to powder and subject the materials to destructive distillation. The product was used only as a medicine, and was noticed as such in 1761 in Lewis's "Materia Medica," under the name of British or petroleum oil, "extracted by distillation from a hard bitumen or a kind of stone coal found in Shropshire and other parts of England." The substance and the method of procuring it received occasional notice in the scientific journals; the earliest paper of much interest, containing an account of Dr. Clayton's experiments, was published in the "Philosophical Transactions" of January, 1739. But it was about ninety years after this before any decided advance was made in adding to our knowledge of the products of the slow distillation of organic bodies. In 1845 Selligue, a French chemist, published full details of his experiments. In this specification Selligue enumerates eleven different products of the distillation.

For several years the only petroleum product considered of value was kerosene, and attempts were then made to utilize the "by-products." At the present time there are at least ten commercial articles obtained from petroleum, and some of them are consumed in enormous quantities. We have first, rhigolene, a most volatile fluid, often used as an anæsthetic in surgical operations; second, gasoline; three different kinds of naphthas; six, kerosene; seven, mineral sperm oil; eight, neutral lubricating oil; nine, paraffine lubricating oil; ten paraffine wax; eleven, residuum. This last is used in the manufacture of lubricating oils.

It remains to note that for the fiscal year ending June 30th, 1891, the export of kerosene from the United States was nearly 600,000,000 gallons, valued at about $40,000,000. For the same period the value of all mineral oils exported from this country amounted to $52,000,000.

ZULUS MAKING FIRE.

CHAPTER V.

GAS LIGHT.

THE old Belgian chemist Van Helmont, who died in 1644, is generally accredited with the invention of the word "gas." He expressly says: "This vapor, hitherto unknown, I call by a new name, 'gas.'" According to some authorities the word is derived from the German "geist"—a "ghost or spirit." Many writers, from the fourteenth to the seventeenth century, allude to a volatile essence — but they always term it "spiritus." Van Helmont was the first to use the word which we now commonly employ. His investigations were confined largely to atmospheric phenomena, and resulted in nothing which added materially to science.

Illuminating gas is, to a limited extent, obtained from natural sources—but the great supplies are made from the following substances: 1, coal; 2, wood; 3, peat; 4, resin; 5, petroleum; 6, oils and fats; 7, water and coke. There are many localities where combustible gases have long been known to issue from the earth. Gas has been used in China for centuries, conveyed in bamboo tubes from fissures in salt mines, in excavations from 1200 to 1600 ft. in depth. Near the Caspian Sea, in Asia, there are several so-called "eter-

nal fires" caused by gas issuing from the soil. In the Szalatna salt mine in Hungary, illuminating gas constantly issues from a muddy clay contained between rock salt strata. To natural gas is probably due the existence of those burning fountains of which we read, where the gas had by accident, perhaps by lightning, been ignited, causing continuous flames; near which religious temples were erected for the purpose of worshiping the fiery element. There is a fire temple about fifteen miles distant from the Russian town of Baku, which is still visited by Persian fire-worshipers.

The first artificial production of illuminating gas from coal is due to Dr. Hales, who describes in a book published in 1727, called "Vegetable Statics," an experiment by which he obtained 180 cubic inches of inflammable air from 158 grains of New Castle coal. In 1659 Mr. Thomas Shirley communicated a paper to the Royal Society on an inflammable gas which issued from a well near Wigan in Lancashire; and the Rev. John Clayton, nearly a century later, in examining the locality, found that the gas issued from a bed of coal. The experiment of subjecting the coal to heat was made, with the result of obtaining an illuminating gas, which being collected in bladders, could be burned in jets. An account of these experiments was communicated to the Royal Society in 1739. Dr. Rickel, professor of Chemistry at Wirsburg, in 1786, lighted his laboratory with gas made by the dry distillation of bones; and in the same year Earl Dundonald, of Scotland, in obtaining tar from the distillation of coals, also collected an illuminating gas, with which he lighted Culross Abbey by way of experiment. The first practical attempt at gas lighting is, however, generally accredited to William Murdoch, who, in 1792, used coal gas for lighting his workshops at

Redruth in Cornwall. His invention remained unnoticed until about 1802, when it was introduced at the Soho foundry of Boulton and Watt, near Birmingham. In the meantime, Lebon, a Frenchman, used gas made from wood for lighting his house, and was therefore considered by the French as the inventor of gas lighting. In 1804 Mr. Murdoch lighted the mills of Phillips and Lee, at Manchester, with gas which yielded an amount of light equal to that of 3,000 sperm candles. In 1813 London Bridge was lighted with gas, and about the same time it was introduced into the streets of that part of the city. From that time its use steadily increased until it became general in the towns and cities in the civilized world.

It has lately been decided to place in the "Hall of Heroes," at the Wallace National Monument, near Stirling, a memorial bust of William Murdoch. Murdoch was a native of Ayrshire, and was born in 1754. In his twenty-third year he traveled to Birmingham, and received employment in the factory of the celebrated firm of Boulton & Watt—of which James Watt, of steam engine fame, was a chief partner. They sent Murdock to Cornwall, and there he remained for a good many years as manager for the firm in the Duchy. Murdoch invented a steam carriage for himself, in which he used to travel between the mines; and his biographers state that but for opposition from his firm he might have anticipated Stevenson with the locomotive.

From his earliest boyhood Murdoch had a turn for mechanical invention, and in regard to gas lighting is reported to have experimented with the parrot coal used in his mother's house in Ayrshire. The idea of the application of the gas to economic purposes is said to

have come to him as he sat by the fire smoking one evening. The gas issuing from the coal attracted his attention. He transferred a small piece of the coal to the bowl of his pipe, closed the top and ignited the gas as it issued from the end of the stem.

The invention, for many reasons, which his biographer fully explains, was never patented. Dissatisfied with his position in Boulton & Watt's establishment, Murdoch returned to Scotland and started a foundry at Old Cumnock for the making of gas apparatus; but in 1798 he went back to Birmingham as manager of the engineering works of his old firm; and in March, 1802, when a general illumination took place over the country in connection with the Peace of Amiens, the Soho Works, lighted up by gas jets, introduced for the first time to any number of the public a sight of the new light. Murdoch subsequently became a partner in the Soho firm. He died in 1839, and was buried in Hansworth Church, where also rest the remains of his friends, Watt and Boulton.

Gas was first used in Paris in 1802, and the streets of the city lighted in 1820.

In the United States gas for illuminating purposes was first manufactured by Mr. David Melville, of Newport, Rhode Island. Melville, who seems to have been a man of ingenious turn, hearing the reports of what was being accomplised in England, gave his attention to the subject, and, as early as 1806, had devised an apparatus by which he lighted his house and the street in front with gas of his own manufacture. This apparatus he improved from time to time until, on March 18th, 1813, it was finally patented by him. By its use he also lighted a cotton mill at Watertown, Massachusetts, and the Wenscutt and Arkwright Mills near Providence, and in 1817 it was employed in the Beaver Tail Lighthouse, this being the

first application of gas to lighthouse purposes. It is said that the new mode of illumination was continued in the lighthouse for one year, giving great satisfaction, but owing to the representations of interested persons who became alarmed at the unexpected success of the experiment, the new light was discontinued at the end of that time.

The larger towns in the states gradually adopted the new system of lighting, Baltimore taking the initiative in 1817.

Gas was used in Boston in 1822, in New York in 1827 ; the streets of the latter named city were lighted with it in 1834. Philadelphia followed in 1835, Chicago in 1840, and Cincinnati in 1841.

The gas meter was invented by Crossley in 1815, and improved upon by Clegg in 1816.

Comparisons of the cost of gas and incandescent electric lighting, and the forecasts of the relative industrial position of these two modes of illumination, have so far been based upon the results at present obtained with the former illuminant. While it has long been known that the consumer realized but a portion of the light which the gas was capable of giving when burned under the best conditions, that is, with clean burners and proper pressure, it has not been supposed that results surpassing these latter were practicable. Recent progress, however, in the construction of burners has shown that gas lighting has by no means reached its limit, but that results are obtainable which are much beyond anything that could have been reasonably expected but a few years ago, and which may enable gas to hold its own as an illuminant against all comers.

The prominence which natural gas has attained within the past few years, as an illuminant

and as fuel, requires, in connection with the foregoing notes on gas, more than a passing notice. Natural gas is an inflammable gas capable of producing light and heat, is generated in vast quantities within the earth in the vicinity of carbonaceous deposits and often in connection with beds of rock-salt. The "eternal fires of Baku" on the shores of the Caspian sea, whence, by the way, it is now proposed to lay a pipe-line across the desert to the Black sea, have burned for many centuries. At Marmaro, Hungary, a deposit of salt at a depth of 120 feet yields a supply of gas sufficient for lighting the mines. In the states of New York, Ohio, and Pennsylvania it has for about thirty years been used to a considerable extent, notably in Fredonia and Bloomfield, N. Y., Erie, Pa., and East Liverpool, Ohio.

The inn at Fredonia was illuminated with natural gas in 1824, on the occasion of Lafayette's visit to the town. In East Liverpool the first well, 450 feet deep, was opened in 1859, and at latest accounts was flowing as copiously as at first, although many other wells have been driven in that immediate neighborhood and flow with equal freedom. The light is brilliant and the combustion so perfect as to be absolutely free from smoke. It is practically the only fuel used for manufacturing purposes in the town. This does not exhaust the list of localities in the United States where natural gas has been in daily use for a number of years; but recent discoveries in Indiana and Pennsylvania have well-nigh caused the earlier ones to be forgotten. The great coal and oil fields of Pennsylvania apparently offer all the conditions of an abundant yield of natural gas, and for many years it has casually served as fuel for some of the pumping-engines of oil-wells. The gas question was, however, so overshadowed by the larger interests of coal and oil production that it did not attract general

attention until, in 1878, it refused to be longer ignored. A well was being driven for oil at Murraysville, 18 miles east from Pittsburg, and had reached the depth of 1,320 feet, when without a moment of warning the entire works at the mouth of the well were blown into the air, and the roar of the escaping gas was heard for a distance of five miles. Four two-inch pipes were laid from the mouth of the well, and the gas burned with wonderful brilliancy. For five years the valuable product was wasted ; but experiment showed that it could be conducted through pipes and it was successfully introduced in steel works near Pittsburg. Other wells were driven in the Murraysville district, and in 1884 the gas was piped to Pittsburg, where it is now so largely used for all purposes of light and heat that it promises altogether to supersede coal. When it was first introduced into the city, such was the anxiety of the people to secure it for domestic and manufacturing purposes that in many instances the plumbing and pipe laying were imperfectly done, and several terrible explosions occurred. These were mainly due to the high pressure at which the gas was passed through the pipes, for, unlike artificial gas, it is odorless and gives no notice of its presence until it is ignited. Careful workmanship and reduction of pressure have so diminished the danger that accidents seldom occur.

What would be the result of multiplying outlets for such enormous interior pressures remains to be seen, and alarmists predict that when the subterranean reservoirs are emptied of gas the vacuum must of necessity be filled by the superincumbent earth. Such a contingency is so remote, however, that few residents are disturbed by the suggestion.

At Murraysville the largest well yields about 30,000,000 cubic feet in twenty-four hours.

The territory underlaid by the gas is as yet not very clearly defined. A belt half a mile wide, running through Murraysville, Pittsburg and Washington, marks a very rich territory. Wells have been driven at different points along this belt and gas has usually been found; but salt water often flows into the wells and renders the gas useless. Another gas-field exists twenty miles northwest of Pittsburg, and still another in Tarentum, about the same distance from the city, on the Allegheny river. But discoveries have been made of practicable sources of supply far outside of these limits in Ohio, Indiana, West Virginia and New York, and as far west as Illinois, Kansas, Utah and Wyoming, and no one at present ventures to predict where it does or does not exist.

The usual method of driving a well is to erect a derrick and sink a six-inch iron pipe until bed-rock is encountered, ordinarily 75 to 100 feet. Eight-inch drills, weighing 3,000 to 4,000 pounds, are then brought into use and worked with an up and down stroke of four or five feet. An eight-inch well is thus bored to a depth of 500 feet when a 5⅝-inch wrought iron pipe is put down and the drilling continued with six-inch drills until gas is struck, when a four-inch pipe is put down. The initial pressure of the gas at the surface of the earth is from 200 pounds to a square inch upward to 1,000 pounds, and even more. This decreases rapidly from leakage and other causes until it is not more than 75 pounds to a square inch ten miles from the well. Contracts are now made in Pittsburg, and other places, to supply private houses with gas for all purposes at less price than was formerly paid for coal.

To set at rest doubts about the future of natural gas, the Wheeling Natural Gas Company tried deeper drilling in the weaker wells, with a result promising a greatly increased

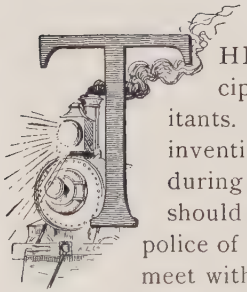
supply, as follows: The original depth of the well was from 2,100 to 2,200 feet, where the third sand is found. At a depth of about 2,300 there began to be signs of another good sand, and a few more plunges of the drill tapped the rock. The gas blew out with such force that the tools would not go down any longer, and the drilling was stopped. The careful test of the first well showed a pressure of over 600 pounds, which is nearly as much as the largest of the famous Grapeville wells. Three or four other wells, when part down to the fourth sand, showed the same result. The introduction of natural gas at Pittsburg has displaced the use of more than 4,500,000 tons of coal a year; of over 50,000 houses there one-half use the gas for fuel and light. The capacity of the natural gas pipe lines reaching that city is about 500,000,000 cubic feet for every twenty-four hours. During the winter season all this gas is consumed, while in the summer there is a surplus. More than 200,000 acres of land in Washington and adjoining counties of Pennsylvania have been drilled for gas wells. Nearly 150,000 tons of iron have been used in manufacturing the pipes through which the 500,000,000 feet of gas that flow from the region daily are conveyed to the places using it. Over $25,000,000 is invested in the business by the organized companies that produce the bulk of the gas. The land and wells represent an outlay of over $17,000,000. The wells now producing are capable of doubling the quantity now demanded for light and heat. Nearly 2,000 miles of mains are required for conducting the supply to the consumers. It is estimated that the use of natural gas has displaced 25,000 tons of coal daily in Western Pennsylvania and Eastern Ohio alone. Besides the wells controlled by the great gas-producing companies, individual owners have wells for the supply of the smaller towns, and every village

and hamlet in the region has enough natural gas running to waste every day to abundantly supply the same number of towns of 10,000 inhabitants each with light and fuel. Farmers near the great Shrader gas well, in the vicinity of Kokomo, Ind., in 1887, harvested wheat by gaslight. The roar of the well could be heard at a distance of eight miles, and its light was seen fifteen miles away. The daily flow is estimated at 15,000,000 cubic feet.

ANCIENT ROMAN LAMP.

CHAPTER VI.

STREET LIGHTS.



THE lighting of streets, while it greatly contributes to ornament our principal cities, adds greatly also to the convenience and security of the inhabitants. But of whatever benefit it may be, it is generally considered as a modern invention. M. St. Evremond says, "The invention of lighting the streets of Paris during the night, by a multitude of lamps, deserves that the most distant nations should go to see what neither the Greeks nor Romans ever thought of for the police of their republics." This opinion appears to be well founded, for we do not meet with any information which definitely proves that the streets of Rome were lighted. Some passages, indeed, in ancient authors, rather indicate the contrary. The Romans would have not considered the use of flambeaux and lanterns necessary on their return from their nocturnal visits, as they seem to have done, had their streets been lighted. Whoever walked the streets of Rome at night without a lantern was under the necessity of creeping home in perfect darkness and in great danger. Meursius endeavors to make it appear that the streets of Rome were lighted, and, in support of this opinion, quotes Am-

mianus Marcellinus and the Life of Julius Cæsar in Seutonius ; but his arguments are far from being convincing. That Naples was not lighted appears from the return of Gito in the night time, mentioned by Petronius. Some circumstances related by ancient authors make it probable that Antioch, Rome, and a few other cities had public lanterns, if not in all of the streets, at least in those which were most frequented. Libanius, who lived in the beginning of the fourth century, says in his Panegyric, where he praises his native city of Antioch, "The light of the sun is succeeded by other lights which are far superior to the lamps lighted by the Egyptians on the festival of Minerva of Sais. The night with us differs from the day only in the appearance of the light ; with regard to labour and employment everything goes on well. Some work continually, but others laugh and amuse themselves with singing." It appears, therefore, that the sophist alludes to the light of the streets. In another passage, in the oration to Ellebechus, the same author tells us that the ropes from which the lamps that ornamented the city were suspended, had been cut by some riotous soldiers not far from the bath. "Proceeding," says he, "to the bath not far off, they cut with their swords the ropes from which were suspended the lamps that afforded light in the night time, to show that the ornaments of the city ought to give way to them." This quotation indicates, at any rate, that there were lamps suspended from ropes near the baths and places of great resort. The following passage of Jerome, however, seems to make it probable, or rather, certain that the streets of Antioch were lighted. In the altercation between a Luciferan and an Orthodox he relates that : "An adherent of the schismatic Lucifer disputed in the street with a true believer till the streets were lighted, when the listening crowd departed ; and that they then

spat in each others' faces and retired." In the edition of the works of that father, preserved to us, we have a short dissertation on the time when this unmanly dispute took place, and the editor shows that it happened at Antioch in the year A. D. 378.

Basilius the Great, in a letter to Martimanus, giving an account of the miserable situation of his native city, Caesarea in Cappadocia, in the year A. D. 371, says that "they had nights without lights." Most commentators explain this passage as if it meant that the lamps had not been lighted. That the streets, not only of Antioch, but also of Edessa, in Syria, were lighted in the fifth century seems proved by a passage in the history of Jesue Stylites. It is there expressly said that Eulogius, governor of Edessa, about the year 505, ordered lamps to be kept burning in the streets during the night, and that he employed for that purpose a part of the oil which was before given to the churches and monasteries.

With regard to lighting of whole cities on festivals, and particularly on joyful occasions, which we call illuminations, that practice seems to be of great antiquity. Of this kind was a particular festival of the Egyptians, during which lamps were placed before all the houses throughout the country, and kept burning all the night. During a certain festival of the Jews, held in December, and called the "Dedication of the Temple," which continued eight days, lamps were hung before the houses. At Rome the forum were lighted when games were exhibited in the night-time ; and Caligula, on a like occasion, caused the whole city to be lighted. As Cicero was returning home late at night, after Catiline's conspiracy had been defeated, lamps and torches were lighted in all the streets in honor of that great orator. The Emperor Constantine caused the whole city of Constantinople to be illuminated with

lamps and wax candles on Easter eve. The fathers of the first century frequently inveigh against the Christians because, to please the heathens, they often illuminated their houses on idolatrous festivals in a more elegant manner than the pagans. This the churchmen considered as a species of idolatry. That the houses of the ancients were illuminated on birthdays, by suspending lamps from chains, is too well known to require proof. Paris and London dispute the priority in the matter of street lighting. At the opening of the sixteenth century, when the streets of Paris were infested with robbers and incendiaries, the inhabitants were ordered to keep lights burning, after nine in the evening, before the windows of their houses; in 1558, vases, filled with pitch and other combustible matter, were kept blazing at distant intervals through the streets. There were at this time nine hundred and twelve streets in Paris, so that the number of lights used must have been less than twenty-seven hundred and thirty-six. A short time afterwards lanterns were provided at the public cost. They were at first only employed during the winter months, but were soon kept constantly burning. Reverberating lamps were next invented, and were usually surrounded by throngs of curious Parisians. In 1777 the road between Paris and Versailles, nearly nine miles in length, was lighted. London claims to have lighted its streets as early as 1414, but the tradition seems doubtful. About 1668 the citizens were ordered to place lamps in front of their houses every night during the winter, but as late as 1736 the rule was imperfectly obeyed; robbers filled the narrow streets, and life and property were never secure in the darkness. Glass lamps were next introduced at the public expense; their number was rapidly increased, and, toward the close of the last century, the citizens of London

were accustomed to boast of their magnificent system of street lights, which far surpassed that of Paris. The roads running from the city for seven or eight miles were lined with crystal lamps. At the crossing of several of them the effect was thought magnificent, and what would now be a row of dim and smoky lights seemed then to be one of the wonders of the times. Novelists and poets celebrated the nightly illumination of the overgrown capital. Vienna, Berlin and other European cities followed the example of Paris and London, and New York and Philadelphia early adopted the custom. Rome alone, still clinging to the usages of the middle ages, refused to light her streets.

The streets of Amsterdam were lighted by lanterns as early as 1669 ; at the Hague an order was issued in October, 1553, that the inhabitants should place lights before their doors; small stone buildings were erected at the corners of the principal streets some time after in which lights were burning ; and in 1678 lamps were placed in all the streets. Copenhagen was first lighted by lamps in 1681 ; Hamburg in 1675 ; in 1679 the inhabitants of Berlin were obliged to hang out a lantern at every third house, and in 1682 lamp posts were erected. Vienna inaugurated street lighting in 1687 ; the lights were hung out in the evening on a signal given by the fire-bell. Leipzic was lighted in 1702 and Dresden in 1705 ; Hanover in 1696 ; Halle in 1728 ; Gottingen in 1735 ; Birmingham in 1733.

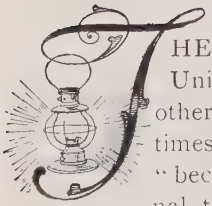
An act of the Common Council of London in the year 1716 gives us a very clear idea of the state of street lighting at that period. It was ordained that all house-keepers, whose houses fronted any street, lane or public passage, should, on every dark night, hang out one or more lights, with sufficient cotton wicks that should continue to burn from 6 o'clock at night until eleven the same night, under penalty of one shilling.

The corporation regulations, however, seem to have been ineffectual. The city was lighted by contract; and the contractors, for liberty to light it, were obliged to pay annually to the city the sum of six hundred pounds. Besides the contractors received only six shillings per annum from every house-keeper whose rent exceeded ten pounds; and all persons who hung out a lantern and candle before their houses were exempted from paying for the public lamps. The streets were lighted no more than one hundred and seventeen nights; and as this gave great opportunity to thieves and robbers to commit depredations in the night-time, the Lord Mayor and Common Council judged it proper, in the year 1736, to apply to Parliament for power to enable them to light the streets of the city in a better manner; and an act was accordingly passed, by which they were empowered to erect a sufficient number of such sort of glass lamps as they should judge proper, and to keep them burning from the setting to the rising of the sun throughout the year.

With the introduction of gas in 1792 came a wonderful advance. Hitherto civilization for three centuries had prided itself upon its lamps and lanterns; it was now to shine in novel brilliancy. The invention spread over the world. London erected hundreds of miles of gas lights; Paris once more called the nations to witness her superb illuminations; and in America the principal cities of the new world lighted up every corner of their busy streets. It was asserted that science had reached its farthest limit in this direction, and the civilized world rested secure in this belief until the startling splendor of the electric light eclipsed all the previous efforts—all the genius of invention—hitherto attempted by man.

CHAPTER VII.

BEACON LIGHTS.



THE curious reader may have noted in many localities in the older parts of the United States prevalence of the name of beacon, applied to hills, headlands and other eminences. The same fact may also be observed in England. In the olden times beacons or signal fires were lighted on them. The old Anglo-Saxon word "becen" means a sign or signal. The ordinary use of these watch fires was to signal the approach of an enemy or spread a call or warning for any purpose, a chain of them often conveying intelligence to a great distance. This mode of signaling prevails to this day among the North American Indians.

Little is known of early history of lighthouses, but sea lights are mentioned by Homer in the Odyssey, and they are also referred to in the Greek poem of Hero and Leander. These must have been merely fires kindled upon the headlands. The most noted lighthouse in the world, for size and antiquity, was the Pharos of Alexandria. This building was the shape of a pyramid, surrounded by a large base, the precise dimensions of which are not known. It was commenced by the first Ptolemy, and was finished about 280 B. C. The

style and workmanship are represented to have been superb, and the material was a white stone. The height was about 400 feet, and it is stated by Josephus that the light, which was always kept burning on top at night, was visible about forty-one miles. It was probably destroyed by an earthquake, but the date of its destruction is not certain ; some authorities give the year 793. Enough is known, however, to make it certain that this tower existed for 1,600 years. The island upon which it is situated was named Pharos, and is at the entrance of the port of Alexandria. The structure took its name from its site. The Pharos of Alexandria was, by the ancients, accounted one of the seven wonders of the world. It cost 800 talents, which is equivalent, in our money, to $825,500. To this day the French word for lighthouse is "phare," and the Italian and Spanish, "faro." While it is true that we read of lighthouses having been erected by the Romans, notably at Ostia, Ravenna, Brindisi, Rhodes and other places, still it is certain that these helps to navigation were rare among the ancients.

There is no mention made in history of any lighthouses constructed by the Romans in Britain. It is not probable that there were any there in the early part of the Saxon period, for the people of that age were too rude to be acquainted with such improvements. Lights were exhibited in various places in England by the corporation of the Trinity House early in the sixteenth century. These did not differ from the ancients, and were simply coal or wood fires placed on the top of towers. The first true lighthouse in England was the Eddystone lighthouse, which was erected by Henry Winstanly in 1696. It was destroyed in the dreadful tempest of November 27, 1703, when Mr. Winstanly and others perished. A

wooden one, by Rudyard, was built by order of Parliament, and all ships were ordered to pay one penny per ton inwards and outwards towards supporting it, in 1708. This light-house was burned the 4th of December, 1755, and one on a better plan erected by Mr. Smeaton, finished 9th of October, 1759. The wood work of this burned in 1770, and was replaced by stone. The foundation having given away, a new one was designed by James W. Douglass, engineer of the Trinity House. The foundation stone was laid by the Duke of Edinburgh, in the presence of the Prince of Wales, 19th of August, 1879. The corner-stone was placed by the Duke on the 1st of June, 1881. One of the most remarkable modern lighthouses is the tower of Cordonan, which was commenced in 1584, and finished in 1610, by Louis de Foix, the construction having occupied twenty-six years. It is situated on a ledge of rocks in the mouth of the Garonne or Gironde, in the Bay of Biscay. The apartments of the tower are highly ornamented, and were not intended for occupation by the keepers. There are four stories, all of different kinds of architecture, and adorned with busts and statues of kings of France and heathen gods. The material is stone. The basement or lower story appears to have been intended as a store-room ; the second story is called the king's apartments ; the third is a chapel, and the fourth consists of a dome supported by columns—a kind of lower lantern. Above this was originally a lantern formed of a stone dome and eight columns. The total height of the tower from its base to the upper point of the lantern dome was 146 feet, and from the rock 162 feet. In the upper lantern a fire of oak wood was kept burning at night for about 100 years, when, in 1717, the fire having weakened the stone supports by calcimining them, the upper lantern was taken down and the light was

kept in the lower lantern. As it did not show well there, an iron lantern was erected in 1727, above this, in place of the old stone lantern, and coal was used for fuel instead of wood.

The early history of lighthouses in the United States is involved in obscurity. All built prior to 1789 were ceded to the federal government by the respective states near the time of the adoption of the federal constitution, and the records of the erection and maintenance of the lighthouses before that date are buried among the archives of the several states. The date of the first coast light in the United States is 1673 ; the first lighthouse was built on Little Brewster Island, in Boston harbor, 1715. The government accepted cession of all lighthouses August 7th, 1789 ; lighthouse control was vested in the commissioner of the revenue, 1792 ; restored to the secretary of the treasury in 1802 ; vested again in the commissioner, 1813 ; vested in the fifth auditor of the treasury, 1820 ; first lighthouse board appointed 21st of May, 1851 ; permanent board organized, 1852.

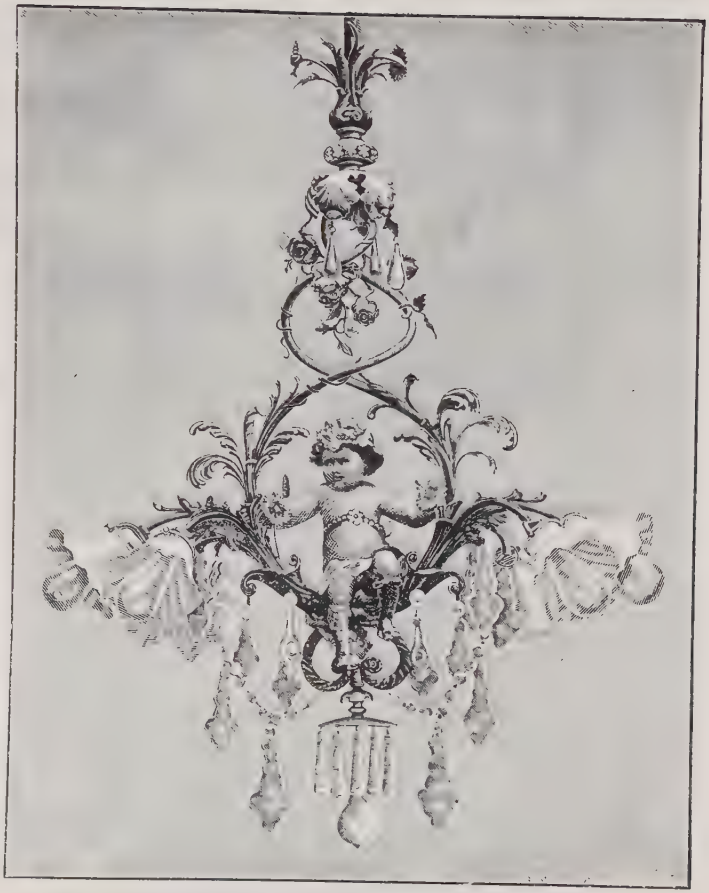
It is known that the ports of Portland, Portsmouth and Newburyport, Cape Ann, Boston, Plymouth, Nantucket, Newport, New London, New York, the capes of the Delaware, the capes of the Chesapeake, the port of Charleston and the mouth of the Savannah River were lighted before 1789. The buildings were generally of rough stone or wood, tower surmounted by large iron lanterns. With a few exceptions they have been all rebuilt. They were generally of small height, and the illuminating apparatus was of the rudest description. About the year 1852 the general introduction of the lens or Fresnal system of lighthouse illumination was commenced, and all the lighthouses of the United States are now furnished

with this apparatus. Many of the lighthouses of the United States are unsurpassed by any in the world, and are of exceedingly difficult construction. The most noted is that of Minot's Ledge in Massachusetts Bay, first erected in 1845.

The source of light in these lighthouses is principally oil, but in harbor lights gas has been successfully used. The magneto-electric light is the most brilliant yet produced. Lime light has also been successfully employed.

The United States maintains lights upon over 10,000 nautical miles of coast and river navigation. The number of lights, range lenses, lens lanterns, staked lights, light-ships, buoys and fog signals employed is over 4,000, and for this service the government expends annually upwards of $3,000,000.

ROMAN LANTERN



MODERN ELECTRIC LAMP

CHAPTER VIII.

THE ELECTRIC LIGHT.

NY attempt to give a detailed history of electricity in this brief sketch on artificial light would be manifestly impossible. The age of electricity, with its splendid achievements, has produced a stupendous literature, and the mere record of inventions and improvements would alone fill a volume. A short review of the inception and growth of this wonderful illuminant is all that can be presented in this necessarily restricted treatise.

The word electricity is derived from the Greek, and means "amber," a substance described by Thales of Miletus, six centuries before Christ, as possessing the property, when rubbed with a piece of silk, of attracting light bodies; this he ascribed to the presence of a soul, which, when excited, left the body and brought the light bodies to it. Theophrastus and Pliny mention the power of amber to attract straws and dry leaves, and also the possession of the same property by the mineral tourmaline. The electricity of the torpedo fish was known to the ancients, as we learn from Pliny and Aristotle, or rather it was known that the fish had the power of producing certain physiological effects, but their explanation or the

MODERN ELECTRIC LAMP

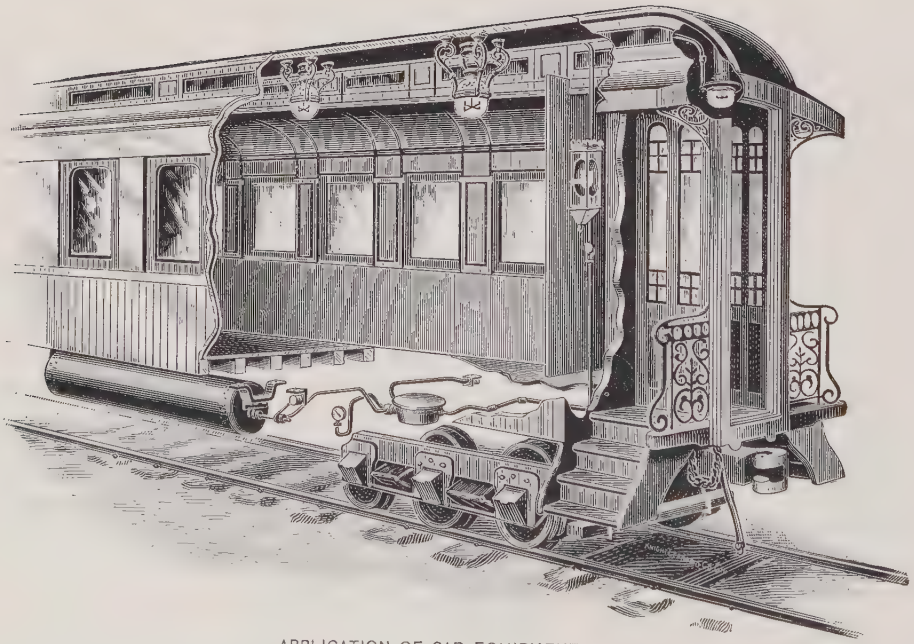
relation which they bore to the property of amber was unknown. As regards the science of electricity a record of the simple phenomena of attraction and repulsion is all that has been handed down to us by them, and but little knowledge of the subject was acquired until toward the end of the sixteenth century, when Dr. Gilbert, of Colchester, England, made a series of experiment, on account of which he has been called the founder of the science. This title, however, can scarcely be justly applied to any one individual, especially at that early day, when a few isolated facts, as yet unconnected with any mathematical law, were all that was known. Otto Von Guericke constructed an electric machine about 1647 ; Stephen Gray, between 1720 and 1736, announced several electrical phenomena ; the Leyden jar was discovered by Kleist in 1745 ; Benjamin Franklin announced his theory of a single fluid in 1747, and demonstrated the identity of the electric spark and lightning drawing down electricity from a cloud by means of a kite in June, 1752 ; the discoveries of Galvani, Volta, and others followed in rapid succession to the close of the eighteenth century.

The use of electricity as an illuminant was a matter of slow growth. Sir Humphrey Davy produced electric light with carbon points in 1802, and Faraday, in 1831, produced sparks by the rotation of a magnet. An apparatus for regulating the electric light was devised in 1846 by W. Staite, and by Petrie in 1848. Jules Dubosqu's electric lamp appeared at the Paris exhibition in 1855, and was first employed by Prof. Tyndall, at the Royal Institution, London, for illustrating lectures on light and colors, in 1856.

The new Westminster bridge, London, was illuminated by Watson's electric light in 1858; the magneto-electric light, devised by Prof. Holmes, successfully tried at the South Foreland

lighthouse, Dover, 1858 and 1859. The French government ordered eight lighthouses to be illuminated by electric light April, 1861; electric candle, invented by Paul Jablochkoff, reported to the Academy of Sciences at Paris, October, 1876. In September, 1878, T. A. Edison announced at New York his discovery of a method of producing a great number of lights and much mechanical power from a dynamo-electric machine. This discovery caused a panic among gas companies in London, and a great depression in the value of shares. Though the electric light was discovered by Davy in 1802–10, it was not until 1844 that it was introduced into our labratories by Foucault; it was not until 1878 that Jablochkoff and Brush showed how to light up our streets effectually and practically; it was not until 1881 that Edison and Swan showed how our homes could be illuminated.

Of the vast number of improvements which are being made constantly, space will not permit us to speak. Electricity in some form or another has become a part of civilized life in this age of marvels, and we are told by the scientists that even now we are just beginning to know a little regarding this wonderful fluid.



APPLICATION OF CAR EQUIPMENT.

THE PINTSCH LIGHT.

CHAPTER IX.

THE PINTSCH LIGHT—RAILWAY CAR LIGHTING.

ERRIE England, seven and sixty years ago, and bright September weather! The small town of Darlington is filled with a throng of excited people! No May-day festival within the memory of the oldest inhabitant compares with this occasion, and, although these simple folk do not realize it, a chapter of momentous history in the world's progress is this day to be opened. A few came to rejoice, more to see a total collapse and many prophets of evil who expected to "see the thing blow up." One man there was, keen-eyed, energetic, hopeful, forty-four years of age, who alone seemed master of the situation; that was George Stephenson, genius, inventor, father of railway passenger traffic.

The opening was, however, auspicious. The proceedings commenced at Brusselton Incline, about nine miles above Darlington, where the fixed engine drew a train of loaded

wagons up the incline from the west and lowered them on the east side. At the foot of the incline a locomotive was in readiness to receive them, Stephenson himself driving the engine. The train consisted of six wagons loaded with coal and flour; after these was the passenger coach, filled with directors and their friends, and then twenty-one wagons fitted up with temporary seats for passengers; and lastly came six wagon loads of coal, making in all a train of thirty-eight vehicles. Strange to say a man on horseback headed the procession! As the locomotive was supposed to be able to move only at the rate of from four to six miles an hour, it was deemed a dangerous position for the daring horseman, but he was glad to clear the way when the speed of the engine reached twelve miles an hour. The local chronicler of the day almost went beside himself in describing the extraordinary event: "The signal being given," he says, "the engine started off with the immense train of carriages; and such was its velocity, that in some parts the speed was frequently twelve miles an hour." By the time it reached Stockton, there were about 600 persons on the train, or hanging onto the wagons, which must have gone a safe and steady pace of from four to six miles an hour from Darlington. "The arrival at Stockton," it is added, "excited a deep interest and admiration." The working of the line then commenced, and the results were such as to surprise the most sanguine of its projectors. The traffic upon which they had formed their estimates of profits proved to be small in comparison with that which flowed in upon them, more than they had ever dreamed of. This was the 27th of September, 1825. At first, passengers were not thought of, and it was only while the works were in progress that the starting of a passenger coach was seriously contemplated. The number of persons traveling between the two towns

THE PINTSCH LIGHT.

was very small; and it was not known whether these would risk their lives upon the iron road. It was determined, however, to make trial of a railway coach, and Mr. Stephenson was authorized to have one built at Newcastle, at the cost of the company. This was done accordingly, and the first railway carriage was built after our engineer's design. It was, however, a very modest, and indeed a somewhat uncouth machine, more resembling the caravans still to be seen at county fairs containing the great "Giant and Dwarf," and other wonders of the world, than a passenger coach of any extant form. A row of seats ran along each side of the interior, and a long table was fixed in the center; the access being by means of a door at the back end, in the manner of an omnibus. This coach arrived from Newcastle the day before the opening, and formed a part of the railway procession above described. Mr. Stephenson was consulted as to the name of the coach, and he at once suggested "Experiment," and by this name it was called. Such was the sole passenger-carrying stock of the Stockton & Darlington Company in the year 1825. But this "Experiment" proved the forerunner of a mighty traffic, and a long time did not elapse before it was displaced not only by improved coaches "still drawn by horses," but afterwards by long trains of passenger carriages drawn by locomotive engines. The "Experiment" was fairly started as a passenger coach on the 10th of October, 1825, a fortnight after the opening of the line. It was drawn by one horse and performed a journey daily each way between the two towns, accomplishing the distance of twelve miles in about two hours. The fare charged was a shilling without distinction of class, and each passenger was allowed fourteen pounds of luggage free. The "Experiment" was not, however, worked by the company, but was let to

THE "EXPERIMENT."

contractors who worked it under arrangement whereby toll was paid for the use of the line, rent of booking cabins, etc. There were two separate coach companies in Stockton, and amusing collisions sometimes occurred between the drivers, who found on the rail a novel element for contention. Coaches cannot pass each other on the rail as on the road, and, as the line was single, with four sidings in the mile, when two coaches met, or two trains, or coach and train, the question arose which of the drivers must go back? This was not always settled in silence. As to trains it came to be a sort of an understanding that empty should give way to loaded wagons, and, as to trains and coaches, that the passengers should have preference over coaches; while coaches, when they met, must quarrel it out. At length, midway between sidings, a post was erected and a rule was laid down that he who had passed the pillar must go on and the coming man go back. At the Goose Pool and Early Nook, it was common for the coaches to stop, and there, as Jonathan would say, passengers and coachmen "liquored." One coach, introduced by an inn-keeper, was a compound of two mourning coaches, an approximation to the real railway coach, which still adheres with multiplying exceptions to the stage coach type.

One, Thomas Dixon, who drove the "Experiment" between Darlington and Sheldon, is the inventor of carriage lighting on the rail. On a dark winter night, having compassion on his passengers, he would buy a penny candle and place it lighted amongst them on the table of the "Experiment," the first railway coach, "which, by the way, ended its days at Sheldon as a railway cabin, being also the first coach on the rail, 'first, second and third-class jammed all into one,' that indulged its customers with light in darkness."

Here, then, we have the first instance of car lighting on record. From that time until within recent years candles have not ceased to be used as car lights. Large sized candles giving about two candles light have been generally used, and more or less elaborate fixtures and candlesticks devised for them. After candles sperm oil was used, and is still, by some roads, but its use has been quite generally superseded by mineral oils of high fire test.

In 1867 there was an old passenger coach still in use on the Camden and Amboy Railroad which had a side door opening, and was particularly noticeable for the great variety of lamps with which it was fitted. The lamps appear to have failed dismally, and the car was again lighted by two candles.

At the Chicago Railway Exhibition of 1883, one of the exhibitions was an eight-wheeled passenger car built in 1840 for the Tioga Railway by the Harlan and Hollingsworth Co., of Wilmington, Delaware. It had been in service from that time up to the date of the exposition, and its arrangements showed that marked progress had been made in its construction, although it lacked a number of useful improvements. The National Car Builder in noticing it said: "The seats are of the same pattern as the common seats of to-day. Their frames are iron, and their arms of walnut, the upholstering being plain and of leather. The body of the car has the following dimensions, viz.: 8 ft. 4 in. by 36 feet. The timbers are about the same as those put in to-day, excepting that the end sills are mortised into the side sills. The body is supported by no springs—aside from the ordinary rubbers in the pedestals. On the original trucks, which lasted for twenty-eight years, the wheels were outside of the bearings. The car is fitted with the ordinary freight draw-bar and chain brakes. The only

ventilation afforded is that by means of a ten-inch flue in the center of the car. Light is supplied by two candles, one in each end of the car. There are no closets, lavatories, or water coolers in the car. One stove is furnished in the winter. A curious fixture about the windows is that they do not raise—the panels between the windows being raised instead. This feature is, we believe, still to be found upon some other roads. This antique car originally cost $2,000, and has a recorded mileage of 1,100,000 miles." Candles and lamps were in use in about the same proportion until the era of the Pullman Palace Sleeping Car, built by Geo. M. Pullman, in 1858, and with these cars came improvements in car lamps of every possible description.

The two illuminants used in car lighting now most prominently before the public are gas and electricity. "There can be," says an eminent authority, "no conflict between gas and electricity viewed from a conservative commercial standpoint—each has its province." There can be no question of this when car lighting is considered. The electric light, brilliant as its achievements are, has not been a pronounced success in the lighting of railway trains. The gas light remains supreme here, and the most perfect illuminant yet produced is the Pintsch gas light.

There are many reasons why gas light for this service is the best—and the first item to consider is that of expense. With electric light, constant attendance of an expert electrician is necessary. No ordinary train hand can undertake the supervision of "dynamos," a "primary," or a "secondary" storage battery. This requires trained skill for which high wages must be paid.

The practical use of batteries of either sort requires the daily removal of about 1,800

pounds' weight of batteries to and from each car, and the time expended in laying up a car for "charging" equals the number of hours during which light is required, all of which consume time, and time is money in railroading.

Where trains are equipped with a small engine and dynamo in the baggage car or a special car, each car depends on the train for its light, or else must be supplied with sufficient storage battery to tide it over such intervals as it may be disconnected. On the one hand the supply is not always certain, and on the other nearly a ton extra weight must be carried by every car using the light in the train. The frequent liability of electric light on a moving train to "go wrong" is too well known to require mention. In any case it will not do to depend solely on the electric light, and a supply of lamps for emergency use must be carried.

The safety of the electric light in railway cars remains to be proven, because there is danger of fire from poor or defective insulation.

But even if electricity could be as cheaply produced and as economically handled as gas, or was as perfectly safe, and that every condition as compared to gas was equal, one fact remains, and that is, the value of the light itself as against gas. There is surely but little argument on this point. Having your choice, would you prefer the glare of electric light in the car or the luminous softness of a gas lamp which sheds a flood of mellow light such as that produced by the Pintsch light? The electric light, great and wonderful as are its victories, comes to a standstill when confronted by this problem. There is yet to be produced an electric light which will compare with gas for a reading light, and the effect of this blinding illuminant upon those who so use it in offices, shaded however it may be, has

already been noted by ophthalmic professors. If the effects of electric light are damaging to the eyes in the quiet of the house, what must it be when intensified by the vibratory motion of the railway train?

Gas light for railway service has been tried from time to time in the history of artificial light, but the Pintsch system is to-day alone in its perfected completeness. This light fulfills all required conditions, leaving nothing to be desired, and there has been nothing left undone to make it the most perfect light yet devised for this branch of commerce. All of the objections which are made to the electric light are met and vanquished by this superb illuminant.

The first thing that strikes the unprofessional observer regarding this invention is the simplicity of the scheme. There is no mystery about it, nothing secret; a child can understand all about it and handle it just as he would the everyday gas jet in his own home. Compressed oil gas, stored in receivers under the car, a pipe the same as any ordinary gas pipe, and a common stop-cock, such as we have at home. There you are; very simple, like all great inventions. There are three, maybe four, Pintsch gas works along the line where the gas is made, and these are not enormous plants, but very modest shops. The gas is made here. Your train rolls in; the receiver under the car is filled in less time than it takes the Pullman porter to get his water-tanks filled, and away you go. Easy enough, isn't it? And at night you have the same softened, luminous light which you use in your home. No glare, no strained optic nerves, no bad results from reading as late as you wish. The porter reaches up and turns off the gas, just as you do at home. No danger of fire, perfect safety,

perfect light. The problem, you will observe, has been solved. A light for car service has been demanded which should be soft, brilliant, cheap, simple, safe, inexpensive, and easily handled. In these particulars the Pintsch is unrivalled.

The use of oil gas lighting for cars, boats, floating buoys, etc., possesses distinct advantages over the use of a gas of lower candle power.

Pintsch's gas can practically be made of about 75 candle-power, and this, after subjection to the losses due under compression, to say 200 pounds to the square inch, will still be from 60 to 65 candles, while nineteen candle gas after the same treatment will not be more than 10 or 11 candles. The use of compressed coal gas has been tried on a large scale and under the most favorable conditions, both in Europe and America, and has been decidedly unsatisfactory. The receivers for carrying the gas under the cars have to be of greater size and the charging stations must be more frequent and equipped with expensive compressing and storage apparatus of large capacity; some six times as much city gas as oil gas being required for a given amount of lighting. The cost is also in favor of the Pintsch gas. The Pintsch gas is now generally available all over the country. It can be obtained in over forty passenger stations, used by more than one hundred and twenty-five railroad companies, which practically distribute the Pintsch gas to most of the principal lines in America, and furnish a supply of this brilliant illuminant to many thousands of passenger coaches, including United States postal, sleeping, parlor, dining and baggage cars.

For manufacturing the gas and compressing it for delivery to the receivers under the cars, is required a plant, consisting of gas works, naturally of small dimensions, which may be located at any available place, and pipe lines connecting the gas with the car yards and

station. For the pipe lines three-fourths strong iron pipe is used, and if the length be great, and quick charging of the cars is desired, an accumulator from which the gas is drawn for the cars is placed at the yard. In laying the lines no provision is needed for draining or drips. All moisture and vapors are effectively removed during the process of compression. Briefly, then, in conclusion, the salient points of this wonderful invention are as follows: The gas, as used in the Pintsch system, is a fixed gas, made from crude petroleum, which, after being thoroughly purified, is compressed in storage tanks, from whence it is drawn and supplied to the receivers underneath the cars, as it is needed, at a pressure of 150 pounds to the square inch. The gas, before passing from the receiver into the car and to the lamps, passes through an automatic regulator which keeps the pressure in the pipes and at the lamps at one-third of an ounce to the square inch, thus doing away with all high pressure in the car. And whether there be one or ten atmospheres in the receivers underneath the car, the pressure at the burners is always the same.

This mode of car illumination is the only perfectly safe method at present in existence. In case of accident, the lights in the car immediately go out; and if the pipes underneath are broken, the gas under pressure instantly escapes into the air.

The man whose genius evolved this magnificent discovery was the late Julius Pintsch, of Berlin, who, seeing the necessity of a more efficient light for railway cars than the dim, flickering oil lamp or the tallow candle which was then in use in some parts of Europe, invented and perfected the system of car lighting with gas which now bears his name. Among other luxuries and conveniences on the Union Pacific, the World's Pictorial Line, will be

found the Pintsch light—an important addition to the already perfect equipment of that system.

This great national highway is so well known, not only throughout the United States, but all over the world, that a mere reference to it would seem sufficient, yet for the benefit of those who have never had the pleasure of riding over its smooth track, and thus had an opportunity of gazing upon the fine scenery along its route, the following description is given :

It formed a part of the first transcontinental line of railroad from ocean to ocean and was conceived, and its construction authorized as a war measure, the needs of the government during the War of the Rebellion having clearly shown the necessity for it. When first talked of, many thought the feat of constructing a line of railroad over the Rocky Mountains an utter impossibility. Many of those who had crossed the plains, deserts and mountains to California in 1849–50, *knew* very well a railroad could not be built there, for "how could a locomotive ascend a mountain where six yoke of oxen could scarcely haul a wagon?" It must be remembered that the line of this road follows almost exactly the old emigrant wagon road, not only on the plains on the north side of the Platte river, through the State of Nebraska, but in fact all the way to Ogden, in Utah Territory. In the days of '49–50, when long trains of gold-seekers, after outfitting in Council Bluffs, wended their way over the plains, the country was filled with hostile Indians, herds of buffalo, deer and antelope. There was scarcely a house west of the Elkhorn river, within twenty miles of Omaha. Now the traveler sits in a luxurious car, illuminated by the Pintsch light, and is whirled over the smooth railroad at forty miles an hour, past villages, towns and cities filled with active, busy, intelligent people, and as far as the eye can reach on either side of the road, farms join each other

and a million and a half of people live in the State of Nebraska, through which the road runs.

It is a pleasant occupation, as one is whirled thus swiftly along, to close his eyes and let the present aspect of prosperity and thriftiness roll away, and call up scenes of early days which have now passed into the history of this country.

A long train of covered wagons, or prairie schooners, hauled by weary looking oxen, which find a scanty subsistence on the tufts of buffalo grass, the only feed for stock. In the wagons the women and children, a led horse, a faithful dog or two and clouds of dust accompanying the procession. At nightfall fires gleam brightly where brush is obtainable ; and the picket guard established lest the thieving Indians, constantly lurking around, should stampede the stock or make an attack on the emigrants, murder them all and rob and pillage the train. Herds of buffalo come down from the uplands to slake their thirst in the waters of the Platte river, and the solitude of night is broken by the shrill bark of coyotes, which hang around the camp to feast upon the debris. But the days of weary travel are over. Swiftly moving trains carry the traveler more miles in an hour than the emigrants made in two days.

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